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TWO TESTS OF WHITE PINE, TRUE FIR, AND DOUGLAS-FIR SEEDSPOTTING IN THE CASCADE RANGE

by

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ABSTRACT

Satisfactory stocking was obtained on seedspots protected by wire screens but generally not on unscreened spots despite extensive baiting of study areas. Western white pine was most successful species used and true firs were least successful. Damping-off, rodents, and insects were responsible for most seedling mortality.

Natural regeneration on high-elevation clearcut areas in the Pacific Northwest is often too slow or of undesirable species. A dependable method of artificially regenerating such areas is needed. Seedspotting offers one possibility; compared with broadcast seeding, it requires fewer seeds. By seedspotting, foresters can avoid some difficulties associated with high-country planting--a short, undependable planting season, heavy winterkill of fall-planted seedlings, and slow growth of planted trees.

This research note concerns two small-scale seedspotting studies. One study compared screened and unscreened seedspots and two species, western white pine (*Pinus monticola*) and either noble fir (*Abies procera*) or Shasta red fir (*A. magnifica* var. *shastensis*). Untreated and endrin-treated[1/] Douglas-fir (*Pseudotsuga menziesii*) and Shasta red fir seed were compared in the second seedspot test as well as the effect of shading and screening seedspots.

Study Areas

Study plots were located on three recently logged, high-elevation areas in the Cascade Range--near Lost Creek, Mount Adams District, Gifford Pinchot National Forest, and on Red Blanket Mountain and at Lusby Cabin, Prospect District, Rogue River National Forest. Characteristics of the clearcuts are tabulated in table 1. To control seed-eating rodents, 1080-treated[2/] wheat was distributed in the fall and spring on each area. The entire acreage in all three clearcuts was also seedspotted as part of a regular regeneration program, thereby minimizing chances for concentrated feeding on study plots by birds or surviving rodents.

Methods

In the first study, two plots were established at Lost Creek and on Red Blanket Mountain. Each plot consisted of 100 seedspots on about one-fourth acre. Prior to seeding, locations for seedspots were selected, scarified with a hand rake to expose at least 1 square foot of mineral soil, and marked with numbered wooden stakes. Then half of the spots were randomly selected for protection by conical screens constructed of 3/8-inch mesh hardware cloth (fig. 1).

The spots were seeded in October of 1964 with untreated seed of nearby sources. At Lost Creek, five western white pine and 10 noble fir seeds were sown over each prepared spot and covered with approximately one-half inch of mineral soil; at Red Blanket, five white pine and 10 Shasta red fir seeds were placed in each spot and similarly covered.

1/ Endrin is the generic name accepted by the Entomological Society of America for the insecticide 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,5,6,7,8,8a-octahydro-1,4-endo-endo-5,8-dimethanonaphthaline. It is somewhat effective in protecting coniferous seeds from destruction by some rodents.

2/ Sodium fluoroacetate.

Table 1.--*Description of clearcuts where study plots were located*

Characteristic	Lost Creek	Red Blanket Mountain	Lusby Cabin
Location	Mount Adams Ranger District, Gifford Pinchot National Forest	Prospect Ranger District, Rogue River National Forest	Prospect Ranger District, Rogue River National Forest
Original forest type	Western hemlock—Douglas-fir—Pacific silver fir	Shasta red fir—mountain hemlock	Douglas-fir—grand fir
Elevation	3,500 feet	6,000 feet	4,500 feet
Aspect and slope	W., 5 percent	SE., 15 percent	W., 15 percent
Size of clearcut	65 acres	35 acres	35 acres
Logged	In 1963	In 1964	In 1959
Slash disposal	Broadcast burned, fall 1963	Piled, not burned	Piled, not burned
Tractor scarification	Fall 1964	Fall 1964	Fall 1964
Baiting	2.8 pounds of 1080[1/] wheat per acre; 40 to 50 grains in protected spots at 20-foot intervals during September. Additional spot baiting in May	1.6 pounds of 1080[1/] wheat per acre spotted in protected spots. Additional spot baiting in May	1.6 pounds of 1080[1/] wheat per acre spotted in protected spots. Additional spot baiting in May
Seeding	Entire unit seed-spotted with 10 to 15 seeds of white pine or Douglas-fir in alternate spots in fall 1964. Spots at 10- by 10-foot spacing	Entire unit seed-spotted with 12 Shasta red fir seeds per spot at 6- by 6-foot spacing	Entire unit seed-spotted with 12 Douglas-fir seeds per spot at 6- by 6-foot spacing

[1/] Sodium fluoroacetate.

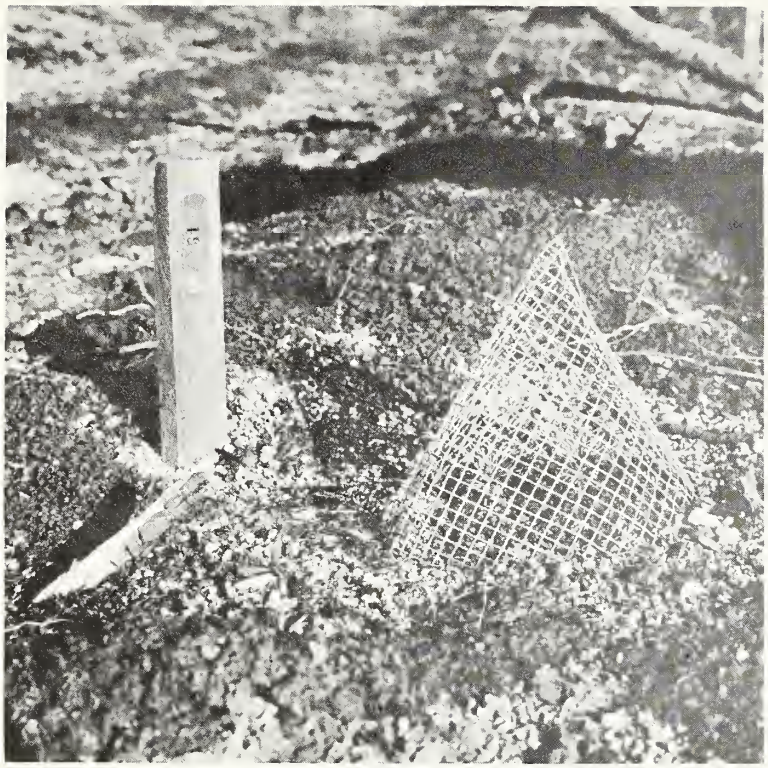

Figure 1.--*Conical screen in place over a seedspot.*

Unequal numbers of white pine and true fir seeds were planted to compensate for differences in percentage of filled seed. Field tests of 200 seeds from each lot, made during the first season of the study, provided these germination results:

Source and species	Germination (Percent)
Lost Creek:	
Western white pine	35.0
Noble fir	38.5
Red Blanket Mountain:	
Western white pine	59.5
Shasta red fir	28.5

However, over half of the Lost Creek and about one-fifth of the Red Blanket western white pine seed in the seedspots did not germinate until the second spring. Consequently, a more realistic germination percent would be 70 and 75 percent, respectively, for the Lost Creek and Red Blanket white pine seed.

The Lost Creek plot was examined six times and the Red Blanket plot five times during the 1965 growing season. Both were checked twice in 1966; the terminal examination was made in late fall. At each examination all seedlings on each seedspot were recorded as live or dead. Cause of mortality was recorded whenever identifiable with reasonable certainty.

Concurrently, the second seedspotting study, including endrin-treated and untreated Shasta red fir and Douglas-fir of local origin, was established on the Prospect Ranger District. The Shasta red fir installation was sown on the same Red Blanket Mountain clearcut used in the first study, and the Douglas-fir on the clearcut at Lusby Cabin. Loss of untreated seed, mortality of germinants, and seedling stocking were compared on (1) unscreened seedspots, (2) unscreened spots shaded on the south by an 8- by 10-inch square of fine mesh screen, and (3) screened spots completely protected by a screen cage. Similar observations were made on unprotected spots seeded with endrin-treated seed of the same species and sources. Fifty replications of these sets of four treatments were installed for each species. Each spot received 12 seeds which were covered with about one-fourth inch of mineral soil. This study was terminated at the end of the first growing season.

Results

White Pine and True Fir Seedspotting Study

After two growing seasons, stocking in screened seedspots was greatly superior to that in unscreened spots (table 2). Nearly twice as many seedlings germinated in screened spots, and survival percentage was significantly greater. As a result, stocking of 2-year-old seedlings in screened seedspots was about twice as much as in unscreened spots at Lost Creek, and over 10 times as much at Red Blanket.

White pine proved more successful than either true fir. Tree percent--percent of viable seed yielding seedlings at the end of the second growing season--was consistently higher for the pine:

	Screened spots (Percent)	Unscreened spots (Percent)
Lost Creek:		
Western white pine	59	18
Noble fir	14	5
Red Blanket Mountain:		
Western white pine	28	3
Shasta red fir	22	1

This is primarily because of the superior survival percentage for western white pine germinants, especially at Lost Creek (table 2).

Table 2.--*Germination, survival, and stocking of western white pine and true firs in screened and unscreened seedspots, first study; data as of October 1966*

Area and treatment	Germinants						2-year-old seedlings						Germinants surviving		
	Spots stocked with--			Seedlings present			Spots stocked with--			Seedlings present					
	Pine	Fir	Either	Pine	Fir	Total	Pine	Fir	Either	Pine	Fir	Total	Pine	Fir	Total
	---- *Percent* ----			---- *Number* ----			---- *Percent* ----			---- *Number* ----			---- *Percent* ----		
Lost Creek:															
Screened	86	94	98	118	157	272	84	36	84	103	28	131	87	18	48
Unscreened	48	88	92	45	107	148	42	20	48	32	10	42	71	9	25
Red Blanket Mountain:															
Screened	82	80	94	107	87	191	52	36	62	53	32	85	50	37	44
Unscreened	54	36	64	64	32	93	6	2	6	6	1	7	11	3	8

The greatest single cause of seedling mortality was damping-off, although most of this was confined to true fir germinants (table 3). Damping-off caused 63 percent of all noble fir mortality and 29 percent of the Shasta red fir mortality. It killed few western white pine germinants. A part of these differences in damping-off of true fir and white pine germinants may be related to time of germination. True firs germinated much earlier at both locations. On May 18, 1965, 96 percent of the noble fir seedlings at Lost Creek had germinated, and 56 percent of these were dead from damping-off. Shasta red fir germination was 57 percent complete on June 8, and 21 percent of these germinants had damped-off. Western white pine seed did not germinate in quantity at either location until mid-June; in fact, 53 percent of the white pine germinants at Lost Creek and 20 percent at Red Blanket did not appear until the second summer.

Taken together, the categories of stem-clipped and missing seedlings (most of which were believed removed by animals, possibly including rodents, birds, slugs, shrews, and insects) accounted for 33 percent of all mortality (table 3). They were the most important categories of mortality for western white pine germinants at both locations. Clipping damage was not differentiated by causative agent, but agents other than rodents and birds were responsible since seedlings were clipped and removed from both screened and unscreened seedspots. If such damage within screens is ascribed primarily to insects and that outside primarily to rodents, then insects and rodents destroyed or damaged comparable numbers of germinants:

	Seedlings clipped or missing (Percent)
Red Blanket Mountain:	
Screened spots	53
Unscreened spots	92
Lost Creek:	
Screened spots	13
Unscreened spots	40

Other causes of mortality were relatively unimportant. Very little mortality occurred during the first winter or during the second growing season (table 3).

Douglas-Fir and Shasta Red Fir Seedspotting Study

Screening of seedspots also produced superior results in the second study (table 4). Screened seedspots contained many more germinants, had higher seedling survival, and had high stocking. In all comparisons, differences between screened and unscreened seedspots were highly significant. There were no significant differences between the

Table 3.--*Amount and causes of seedling mortality by species and season, screened and unscreened seedspots, first study; data as of October 1966*

Item	Lost Creek					Red Blanket Mountain				
	Screened spots		Unscreened spots		Total	Screened spots		Unscreened spots		Total
	White pine	Noble fir	White pine	Noble fir		White pine	Shasta fir	White pine	Shasta fir	
	Number									
Total germinants	118	157	45	107	427	107	87	67	32	293
	Percent[1]									
Mortality by cause:										
First season:[2]										
Damping-off	3	61	2	43	34	0	26	3	6	9
Stem clipped	0	4	0	15	5	20	7	24	56	21
Missing	5	12	18	14	10	19	14	54	28	26
Heat	1	1	7	7	3	0	6	3	3	3
Drought	2	1	2	4	2	5	5	0	0	3
Unknown	1	1	0	0	1	0	0	0	0	0
Total	12	79	29	83	56	43	57	84	94	62
Overwinter:										
Missing	0	(3/)	0	5	1	1	1	0	0	1
Clipped	0	0	0	0	0	3	0	0	0	1
Unknown	1	1	0	0	1	0	0	0	3	(2/)
Total	1	1	0	5	2	4	1	0	3	2
Second season:										
Missing	0	1	0	3	1	2	5	3	0	3
Drought	0	0	0	0	0	2	0	0	0	1
Total	0	1	0	3	1	4	5	3	0	4
Total mortality	13	81	29	91	59	51	63	87	97	68
Seedlings damaged by clipping	2	1	5	7	4	16	17	4	6	13

1/ Individual percentages may not total due to rounding.

2/ Including mortality of white pine germinants appearing between June and November of the second season.

3/ Less than 0.5 percent.

Table 4.--*Germination, survival, and stocking of Shasta red fir and Douglas-fir on seedspots, second study; data as of October 1966*

Item	Screened seedspots	Unscreened seedspots		
		Shaded, untreated seed	Unshaded	
			Treated seed[1]	Untreated seed
Shasta red fir:				
Spots stocked.....Percent..	77	17	10	10
Germinants per spot.....Number..	4.62	2.54	1.77	2.56
Established seedlings per spot.....Number..	3.40	.27	.12	.15
Germinants surviving.....Percent..	74	11	7	6
Douglas-fir:				
Spots stocked.....Percent..	90	45	39	27
Germinants per spot.....Number..	6.02	2.37	2.10	1.35
Established seedlings per spot.....Number..	4.12	.96	.80	.47
Germinants surviving.....Percent..	68	40	38	35

[1] Endrin-treated.

shaded, unscreened seedspots and unshaded, unscreened spots seeded with either treated or untreated seed. Results were similar for both Douglas-fir and Shasta red fir.

Discussion

If 35- to 50-percent seedspot stocking is considered satisfactory, screened seedspots can be considered an unqualified success in both studies. Screened seedspots yielded better results by reducing seed and germinant losses to animals. About twice as many seedlings germinated in screened spots (tables 2 and 4), indicating that prior to germination half of the viable seed in unscreened spots was destroyed by rodents (and possibly shrews). Recovery of rodent-cracked seed hulls from many unscreened seedspots, but none from screened spots, confirmed cause of and differences in seed loss. Rodents also clipped and removed seedlings from unscreened seedspots, as previously pointed out.

Much greater seedling establishment on screened than on unscreened spots strongly suggests that rodent control activities were either inadequate or ineffective.

Western white pine was the most successful and true firs the least successful of the species sown in these two studies; Douglas-fir was intermediate. White pine failed only on unscreened spots at Red Blanket. In the first study, screened seedspots were only 36 percent stocked with true firs, a barely satisfactory showing (table 2). True fir stocking on unscreened spots was unsatisfactory in both studies, ranging from 2 to 20 percent (tables 2 and 4). True fir failures were not due to seed loss or inadequate germination but rather to very heavy seedling mortality (table 3), particularly from damping-off. Douglas-fir achieved 90-percent stocking of screened seedspots; unscreened spots were 27 to 45 percent stocked, but this was at the end of the first growing season and some additional seedling losses are to be expected.

Small seedling losses caused by heat and drought and major losses from insects and rodents, as recorded in the first study, were not surprising. Stein[3/] observed damage of similar magnitude by these agents in seedspottings of sugar pine. The high proportion of noble fir germinants lost to damping-off fungi at Lost Creek was unexpected, although substantial mortality from damping-off has been recorded in other studies of seedspotting at high elevation.[4/] Low overwinter mortality was also

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3/ Stein, William I. A successful direct seeding of sugar pine. U.S. Forest Serv., Pacific Northwest Forest & Range Exp. Sta. Res. Pap. 25, 19 pp., illus. 1957.

4/ Ronco, Frank. Lessons from artificial regeneration studies in a cutover beetle-killed spruce stand in western Colorado. Rocky Mountain Forest & Range Exp. Sta. U.S. Forest Serv. Res. Note RM-90, 8 pp., illus. 1967.

somewhat unexpected, since seeding studies made by Jensen[5/] near Lost Creek showed that frost heaving can be a major cause of mortality of one-season-old seedlings.

Statistical analysis of data from the second study showed that stocking of shaded seedspots or spots seeded with endrin-treated seed was not significantly better than stocking of unshaded spots seeded with untreated seed. Failure of shading to significantly improve seedling survival suggests that, as in the first study, heat and drought were not major causes of mortality. Data on number of germinants (table 4) indicate rodents destroyed substantial amounts of the unprotected Shasta red fir and Douglas-fir seed regardless of whether or not it was endrin-treated.

Conclusions

Poor establishment of seedlings in these small-scale seedspottings of western white pine, true firs, and Douglas-fir, except where screened--and not always then -- indicates we need to know much more about seedspotting to make it a consistently dependable method of artificially regenerating upper-slope forests. Particularly, more information is needed about methods of protecting seed and seedlings from rodents and preventing seedling losses to insects and disease as Stein[6/] has already pointed out.

5/ Jensen, Harold J. Regeneration studies in the High Cascades of southern Washington. Unpublished manuscript on file at the Pacific Northwest Forest & Range Exp. Sta., 13 pp. 1961.

6/ Stein, William I. Seedspotting - revival of an old technique. In Western Reforestation. West. Forest. & Conserv. Ass. Coord. Com. Proc. 1964: 18-20. 1965.